

Atlantic. The *Amphiheliæ* are found in the North Atlantic and Florida seas, besides off Madeira; but *Cladocora debilis* appears to be a local species. The *Balanophyllia* is new, and has no definite alliances. *Ceratotrochus johnsoni* is a remarkable form of a genus of very great distribution; and *Caryophyllia endothecata* is so important a coral that I shall venture to write a separate memoir about its bearings on classification.

EXPLANATION OF PLATE VIII.

- Fig. 1. *Caryophyllia endothecata*, p. 216, natural size.
 2. ———, the calice, magnified,
 3. ———, interseptal loculi, magnified.
 4. ———, costæ, magnified.
 5. *Ceratotrochus johnsoni*, p. 217, natural size.
 6. ———, a second specimen, natural size.
 7. ———, the calice, magnified.
 8. ———, the costæ, magnified.
 9. *Balanophyllia brevis*, p. 219, natural size.
 10. ———, magnified.
 11. ———, calice, magnified.
 12. ———, diagram of the septal arrangement.

On the Arrangement of the *Coralliidæ*, with Descriptions of new or rare Species. By STUART O. RIDLEY, M.A., F.L.S., &c., Assistant in the Zoological Department, British Museum. (Communicated by Dr. GÜNTHER, V.P.Z.S.)

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(Plate IX.)

The small group of species which has been thought worthy of separation from the rest of its Alcyonarian allies as a distinct family under the name *Coralliidæ* (more correctly *Coralliidæ*), is chiefly remarkable in its structural characters for possessing a continuous stony axis, covered by only a thin cortical layer of a softer spiculi-ferous material, into which the polypes are retractile. Its best claim to general notice lies in the fact that the Precious Coral of commerce (*Corallium rubrum*, Costa, rectius *nobile*, Pallas) is one of the only three species hitherto known to exist in the seas of the present time which have been included in it. The other two species are scarcely known, even to students of the group. Thus but one specimen of the species described by Dana (U. S. Expl. Exped., vol. vii. p. 641, pl. lx. fig. 1) under the name of *Corallium secundum* seems to have ever been described; and but one specimen of the third species, described by the late Dr. Gray (P. Z. S. 1860, p. 393, Rad. pl. xviii.) under the name of *Corallium* (subsequently altered to *Hemicorallium*) *johnsoni*, was obtained in the first instance, and I know of no other authentic specimen. The original specimen of this species, however, is fortunately preserved in the national collection; that of

C. secundum is no doubt in America, in company with the other specimens obtained at the same time by the United-States Exploring Expedition. The Red Coral (*C. nobile*) occurs in the Mediterranean, and among the islands (e. g. Cape-Verd Islands, see Wyville Thomson, Voy. 'Challenger,' Atlantic, i. p. 76) lying off the N.W. coast of Africa; it occurs nowhere¹ else, so far as I have been able to discover. *C. secundum* is recorded with doubt as from the Sandwich Islands; it was probably obtained in the Pacific Ocean at any rate; *C. johnsoni* was obtained from Madeira. In the present paper is described a fourth species, and one which is probably not new, belonging to this remarkable and beautiful family: the one was obtained from the island of Mauritius, and is now in the collection at the British Museum; the other is stated to come from Japan, and will shortly be incorporated with the same collection.

Arrangement of the Family.—The only attempt which has been made at classifying the species is that of Dr. Gray in a Note read before this Society, and published in its 'Proceedings' for 1867 (p. 125), and somewhat amplified in 'Catalogue of Lithophytes or Stony Corals' (1870), p. 22. Dr. Gray divided the family and the original single genus *Corallium* into 3 genera, based mainly on the distribution of the "polytypes" (meaning polype-cells, verrucæ of Verrill) on the branches, viz. :—

(1) *Corallium*, with the verrucæ slightly elevated from the cortex and scattered on all sides of the branches (incl. *C. nobile*).

(2) *Pleurocorallium*, branching in a single plane; the verrucæ slightly raised, confined to one surface, and mostly placed on small branches chiefly found near the edges of the main branches (incl. *C. secundum*, Dana).

(3) *Hemicorallium*. The verrucæ prominent, all occurring on one side of the branches (incl. *C. johnsoni*, Gray).

With regard to this arrangement, it seems well to point out that the characters on which it is founded appeal entirely to the naked eye. In the allied members of the same group, the Alcyonaria, Prof. Kölliker (see 'Icones Histiologicæ') and Verrill (see various papers in the Proc. Essex Institute, Trans. Connecticut Academy, American Journal of Science, &c.) have shown good reasons for the belief that the majority of those characters, such as colour, manner of branching, presence or absence of anastomosis between branches, to which alone those writers can appeal who do not make use of a microscope in their researches, must be regarded as usually of no more than secondary importance in the estimation of the mutual affinities of the different subdivisions and species of this group. From personal study I can testify to the truth of this principle in the case of the *Melithæidæ*, which are probably the nearest allies of this family. In them anastomosis of branches may be simply a varietal circumstance; coloration of the internal parts is open to the same remark, and external coloration is far more frequently so; the manner of branching is much the same in all; so that, for classifi-

¹ It is found fossil in the Upper Pliocene and Quaternary deposits of South Italy, cf. Seguenza, Atti Ac. Linc. (3) Mem. sc. fis. mat. nat. iii. pp. 331, 373.

cation, recourse has to be had mainly to the characters of the spicula and of the verrucæ.

The want of good series of individuals of any known species of *Coralliidæ* except *C. nobile* is an obstacle to the full discussion of the natural relations of the different forms; a few facts only can be noted at present as bearing on the subject. Beginning with the comparatively common *Corallium nobile*, Pallas (*rubrum*, Costa) we find a cylindrical axis, usually branching seldom, but dichotomously and most commonly in an arborescent manner, which, though tending towards growth in one plane, yet almost invariably is actually in various planes; the cortex quite conceals any inequalities of the surface; and the verrucæ¹ (or calicles) project dome-like from all sides of the branches. Variations are frequent, especially in mode of growth; but these are by far the commonest characters of the species. The colour of the axis varies not uncommonly from crimson to pale red, rarely to yellow, and more rarely to white; the spicules are of one type, viz. a hexahedral oblong form, the angles being formed by broad truncate but microtuberculate tubercles, which preserve the chief features of their characteristic form throughout all varieties of the external form of the coral. (*Cf.* Lacaze-Duthiers, *Hist. Nat. Corail*, p. 70—"toutefois en recherchant bien, on finit par découvrir une forme qui, résumant toutes les autres, peut être regardée comme la type.")

Corallium (*Hemicorallium*, Gray) *johnsoni*, P. Z. S. 1860, p. 393, *Radiata*, pl. xviii., differs in several particulars from the former species, besides the branching essentially in one plane, the strictly anterior position of the verrucæ, and their considerable protrusion from the surface, which are the chief points insisted on by Dr. Gray. Thus the cream-coloured cortex is about .5 mm. thick, about twice the thickness which it has in *C. nobile*; on the terminal branches the calicles rise abruptly from the surface, are truncate above, and measure 1.5 to 2 mm. in average diameter. The spicules have not hitherto been described; and their characters, in the one case, are so remarkable, and have such an important bearing on the affinities of both the genus and family to which the species belongs, that I now proceed to describe them.

Spicules of two kinds:—(i.) cylindrical, octoradiate, having a short stout shaft terminated at each end by a tubercle; two pairs of tubercles also project from each end of the shaft, in the same plane as the terminal ones, but at right angles to its long axis; on the anterior side (reckoning the two pairs of tubercles just mentioned as lateral) a tubercle projects at right angles to the long axis of the shaft, and also to the plane in which the lateral tubercles lie; on the posterior side a similar tubercle is similarly placed, but at the opposite end of the spicule; the ends of the short, broad, truncate tubercle are microtuberculate with few, sharp, smaller tubercles; size .08 by .053 mm.: this form is exactly similar to that of *C. nobile*, but is slightly smaller. Spicule no. ii. bilobate, having the form of a pair of

¹ I think it best to adopt Verrill's term for those parts of the cortex which are specialized for the reception of the polytypes.

opera-glasses, or of two short globose bottles united by their sides ; consists of two globose masses, often somewhat flattened at distal end, separated by a more or less deep constriction, their surface microtuberculate ; to the proximal extremity of each is attached a short handle-like process, of variable shape, bearing several long tubercles, and about one third the length of the larger lobes ; average maximum size .053 mm. long by .053 mm. across the two lobes ; thickness of lobes, antero-posteriorly, about .044 mm.

The thickness of the cortex appears to be correlated with the smoothness of the hard axis in the stem (higher up this is distinctly striated) ; for in the other species of *Hemicorallium*, *H. secundum*, the thinner cortex appears to be associated with a striated stem. The explanation (physiological) appears to be that the cœnosarcal canals, which would have grooved the surface of the axis, find sufficient protection in the cortex when this is thick.

Turning to *C. (Pleurocorallium, Gray) secundum*, Dana (U.S. Expl. Exp., Zoophytes, vol. vii. p. 641, Atlas, Zooph. pl. lx. fig. 1), we find again the mode of branching to be substantially that in one plane ; here too the polypes are said to be confined to the front or sides of the branches, but to be borne mostly on small branchlets or pinnæ scattered over the edges and front of the main branches—an arrangement differing from that of both the preceding forms, but agreeing with that to be described below in the new species *C. stylasteroides*, with which this species further agrees in the growth in one plane. Unfortunately the spicular characters are unknown ; but, from resemblances which have been found to exist between this and a form described below as a variety of it and agreeing in all generically important characters with *Hemicorallium johnsoni*, I have little doubt of its similar generic identity with that species : therefore one of the genera *Pleurocorallium* and *Hemicorallium* must give way, and the former must stand, having precedence in description.

Hemicorallium therefore = *Pleurocorallium* ; and *Hemicorallium johnsoni* = *Pleurocorallium johnsoni*.

Looking at the relations of *C. nobile* to the species described below as new under the name of *C. stylasteroides*, we find a thin cortex in both, a low polype-verruca, and a spicule differing only in size ; and it is only in those characters which, as I have stated, I believe to be less essential in the classification of this Order, viz. mode of branching, colour, and form of axis (*i. e.* cylindrical or oblong in section), that we find great differences ; and the first two of these have been already seen to vary widely in *C. rubrum*, and in their variation to approximate that species to *C. stylasteroides*.

No other recent species has been described.

The only other species with which I am acquainted are the fossil forms *C. pallidum*, Michelin (Iconogr. Zoophytol. p. 16, pl. xv. fig. 9), from the Miocene of Italy and Tertiaries of Scinde, and *C. beckii*, M.-Edw. and Haime (Distr. méth. polyp. palæoz. p. 188), from the White Chalk of Faxœ. The former is distinguished from our species by having the method of branching of *C. nobile*, viz. cylindrical branches given off at considerable intervals ; and it appears to

belong to *Corallium* s. str., and is perhaps identical with *C. nobile* (see below, p. 232). In *C. beckii* the branches anastomose and are terminally dilated, both of which are characters quite wanting (as constant characters) in *C. nobile* as in all other known species; its systematic position in the family is quite uncertain.

I will now proceed to describe, first, the new species, and next the form which I have said is probably distinct, and then give a table showing the arrangement which these additions to our knowledge seem to render necessary. I will conclude with some remarks on the family and its allies, and some further notes on the fossil forms.

CORALLIUM STYLASTEROIDES, sp. nov. (Plate IX. figs. 1-4).

Normally branching in one plane. Stem stout, irregular in transverse section. Branching luxuriant, apparently normally dichotomous, but subject to considerable variation. Branches tortuous, decidedly compressed laterally in the case of all but the peripheral members, arising from the antero-lateral rather than the postero-lateral aspects of the stem or branches from which they may be derived, diminishing gradually in thickness towards the peripheral part. A few small branchlets are scattered on sides of the larger branches irregularly, and are, together with the terminal branchlets, generally subclavate in form, consisting of a slightly contracted basal portion and an enlarged, pointed, and polyhedral terminal portion. Posterior aspect of main branches very convex, of lesser branches less so. Axis of corallum hard, compact, but perforated by a few canals (normal, or due to parasites?) of about 1 mm. diameter, which issue distally at various points on the lateral aspects of the branches, the openings being often covered by a curved lamina of hard material; colour pure white throughout.

Longitudinal striæ of surface fine, about four to 1 mm.; grooves for polypes generally with a narrow raised lip on each side; length of grooves 1.5 to 2 mm. long (in direction of branches) by about .75 mm. broad, and about .5 mm. deep in the centre, which consists of a smooth-walled hemispherical pit. Surface of hard axis covered by a very thin spicular cortex, which does not conceal the subjacent striæ; it is beset with minute projecting points (visible only with the aid of a lens) arranged along the striæ of the hard axis; colour of cortex extremely pale orange. Verrucæ placed in the grooves above mentioned, not projecting beyond their margins, or in slight depressions distributed over all parts of the corallum, but most abundantly on the lateral aspects of the main branches, and on the small terminal and lateral projecting branchlets; their peripheral part consists of a pale pink collar, slightly darker than the general crust; the eight valves are very pale yellow in colour, actual diameter about .75 mm.

Spicules of cortex of one kind only, viz. small, cylindrical, with one terminal tubercle at each end, and a whorl of 3 tubercles surrounding each end, and leaving a slight median space usually bare of tubercles; the tubercles are broad and truncate, the ends bearing

several smaller angular tubercles which point outwards; size ·053 to ·058 mm. long by ·035 mm. broad (including the tubercles); shaft, excluding tubercles, about ·02 mm. broad.

Hab. Mauritius, 75 fathoms.

This species is based on a single dry specimen very finely preserved, obtained recently by the British Museum from a collector in Mauritius, Mr. V. De Robillard, together with some remarkably fine specimens of species of *Gorgonidæ*. Its chief larger measurements are:—Main diameter of common stem¹ 11 mm.; largest branch—antero-posterior diameter at base 10 mm., lateral diameter 7 mm.; at 50 mm. from origin the same diameters are 7 mm. and 5 mm. respectively. Maximum transverse breadth of the whole corallum 135 mm., maximum height 105 mm.

The species differs from all to which names have been hitherto assigned in the elaborateness and peculiarities of its method of branching, with the exception of a specimen which was assigned by Dr. Gray (P. Z. S. 1867, p. 126) to his *Hemicorallium johnsoni*, and which then belonged to the Liverpool Free Museum. This specimen, differing as it does from the typical example of that species in the collection of the British Museum in its slender and strongly arborescent habit, appears to me to be entirely distinct from Dr. Gray's species, a fact which is apparently meant to be indicated by his subsequent statement (Cat. Lithophytes, p. 24) that the so-called animal of his figure is a fleshy Alcyonoid parasitic on a stony coral.

The present species agrees in the mode of branching in one plane with *C. secundum*, Dana (U.S. Expl. Exped., Zoophytes (vii.), p. 641, pl. lx. fig. 1), and also in the fact that many of the polypes are borne on small lateral branchlets; but differs from it (judging by the description) in having polypes on the posterior as well as the anterior surface, as also in the very pale pinkish colour of the cortex (that of *C. secundum* being scarlet), and the pure white of the hard axis (that of *C. secundum* being white and red). The small points which project from the cortex in the lines of Dana's striæ are, perhaps, represented by the small dots represented in Dana's enlarged figure of a polype with adjacent cortex; but these may just as well be *pits* as dots, according to the figure. Nothing is known of the spicules of *C. secundum*; but, as we have seen above, that species must be referred to the genus *Pleurocorallium*. Those of *C. stylasteroides* differ from those of the white variety of *C. nobile* only in their size, which is about one third less than that of the latter; but the excavations for the verrucæ (Plate IX. fig. 3), and the thinness of the cortex, are amply sufficient to prevent its being confounded with that form. The apparent anastomosis between some of the branches is due to fracture and subsequent adherence of the broken pieces to the remainder of the corallum, the reunited pieces having apparently contrived to live.

With regard to the axial tubes of 1 mm. diameter, alluded to in my diagnosis in uncertainty as to their import, they may possibly

¹ Broken off from the actual base.

be due to the same causes as those which produce certain perforations, open at both ends, in the base of some of the small branches, and which are seen in parts forming passages covered in by a thin lamina of hard matter. The latter resemble so much the passages which are seen among the branches of many *Stylasteridæ*, and which are said (see Moseley, Report on Corals of the 'Challenger' Expedition, p. 78) in this case to be produced by the growth of the coral over an intruding Aphroditacean Worm which has adhered to the branches, that I must attribute with probability a similar origin to those of the *Corallium*.

It is a different matter with the deeper tubes belonging to the main stem and branches. In the present base of the main stem, they are seen by its fracture to be excentric in position, somewhat variable in size: one of them contains a fine yellowish deposit containing minute siliceous particles and siliceous spicules, viz. spined acuates and acerates, about .14 mm. long and .009 to .0177 thick, and acerates about .28 by .024 mm., with fragments of spinulates, triradiates, and some minute anchorate spicules. Lacaze-Duthiers (Hist. Nat. du Corail, Paris, 1864, p. 333) mentions small Annelids allied to the Serpulæ as sometimes attaching themselves to the surface of the Red Coral, and being covered up by the centrifugal growth of the corallum; but these tubes present no such distinct lining of carbonate of lime as this hypothesis demands. If not merely remains of the cœnosarcal canal-system, they are probably produced by the burrowing of boring Sponges (e. g. *Cliona*, *Samus*, *Alectona*), such as are common in *Stylaster* and Astræid Madreporæ, or Worms (e. g. *Sipunculus*), such as occur in *Heteropsammia*. Lacaze-Duthiers attributes such cavities generally to "la érosion des éponges ou des vers," and mentions that such perforated specimens of coral are technically described as "piqué" by dealers. Some of the spicules mentioned above as occurring in one of the tubes appear to have been simply introduced with some bottom-material which has been accidentally washed into the tube, as their forms do not belong to any of the boring Sponges; but the spined forms mentioned may very well belong to a boring species allied to *Cliona purpurea*, Hancock, or *Alectona millari*, Carter, two species of boring Sponges.

Kölliker (Icon: Histiol. p. 146, pl. xvi. fig. 8) mentions and figures a smaller central cavity as occurring in some of his transverse sections of the Red Coral, but is unable to explain its occurrence. The question of the origin of the present passages receives, however, no help from Kölliker's observations, as his figure shows a discoloured ring surrounding the passages; they probably represent the horny axial tract found in the stems of most coralligenous Alcyonarians. In this case, if they prove to be constant in their occurrence, they would seriously interfere with the value of the coral for jewellery-purposes, should it be attempted in the future to put it, like the pale varieties of the Red Coral, to such a use. But the absence of a subtle tint of any kind, such as that which the varieties of the Red Coral generally possess, renders such an attempt improbable. The

considerable depth at which this specimen was obtained, not being greater than that from which *Corallium* is brought to the surface in the Mediterranean, need not of itself prevent such an undertaking.

PLEUROCORALLIUM SECUNDUM, Dana, var. ELATIOR. (Plate IX. figs. 6-11).

Branching normally in one plane. Stem strong, oval in transverse section, the longest diameter being the lateral one. Mode of branching normally dichotomous combined with pinnation. Distance between points of origin of main branches considerable, but sides of branches occupied in these intervals by small branches or pinnæ, irregular in size and point of occurrence, occasionally found on the anterior surface; branches of main system decreasing gradually in thickness to the extremity of the corallum, somewhat tortuous, decidedly compressed from front to back in most places, the lateral diameter being to the antero-posterior about 11:9; pinnæ short, coming rapidly to a point, circular (or almost so) in transverse section, generally curved or tortuous, and not exceeding 20 mm. in length. Axis of corallum hard, not easily indented with a knife, solid; in main stem, and for a considerable distance up the main branches, of a deep crimson-red colour with a tinge of scarlet, resembling the colour of dried salmon's flesh; in the upper branches and the pinnæ the central portion of the axis becomes paler, being at first pink and finally white, this axial pale tract widening as it approaches the extremity of the branches or pinnæ, the axes of whose apices are white throughout. Surface of hard axis very finely striated in the longitudinal direction, with about five striæ to 1 mm., more deeply striated on smaller branches and pinnæ; surface otherwise even, with the exception of a tendency to roughness at the ends of the pinnæ, and very slight (almost imperceptible) shallow depressions beneath the calicles. Cortex about .3 mm. in thickness, completely concealing all inequalities of the axis, except at ends of pinnæ; friable, of a pale vermilion colour; posterior and lateral surfaces even, and devoid of verrucæ, with the exception of a few scattered ones on and near the stem and at the ends of some pinnæ; anterior surface beset with verrucæ at intervals of 1 to 3 mm., and with minute punctiform elevations, visible only by the aid of a lens, uniformly distributed over the intermediate spaces to the number of about 25 in a square millimetre. Verrucæ broad, truncate above, rising abruptly from surface; of same colour as the general cortex; in retraction they may be completely closed; wrinkles between the 8 valves generally obsolete or very slight in the retracted state; diameter of verrucæ 1 to 1.25 mm., projection from cortex about .5 mm.

Spicules of cortex of two kinds, viz.:—(i.) Cylindrical, sexradiate, colourless, with short thick axis; at each extremity two tubercles project from the side of the shaft (which does not project beyond them), at right angles to it; on each of the anterior and posterior aspects of the spicule (reckoning those which bear the above-mentioned four tubercles as the lateral ones) one tubercle is set at right angles to the long axis of the shaft, near its extremity, but at opposite ends

of it; the spicule is thus sexradiate. (Varieties of the typical form occur, in which both the tubercles of the antero-posterior faces may be on one side; in this case one of them may be double, or one of them may be subterminal and appear to project beyond the end of the shaft; or one of them may be wanting, or one may occur in addition at one or both ends; in the latter case the result is an octoradiate like that of *Corallium nobile*.) Tubercles short, broad, expanding from their base into fungiform disks, themselves tuberculate with numerous short, rather blunt, small tubercles. Size (average maximum) 0·7 by 0·53 mm. (ii.) Second form of spicule shaped like an opera-glass, viz. like two short globular bottles attached by their sides; it consists of two subspherical lobes separated by a constriction, generally with tubercular excrescences borne on secondary lobes on their surface, and minute tubercles on their surface and edges; the upper margin of each lobe is produced into a short, strongly tuberculate, handle-like process of variable shape. Generally coloured pale red. Average maximum size:—length (across lobes) 0·6 mm., breadth (from apex of handle to lower extremity of lobes) 0·53 mm., maximum thickness of lobe from front to back 0·35 mm. (It is practically identical with the similar spicule of *P. johnsoni*.)

Hab. Said to come from Japan.

This most interesting form is represented by two portions, perhaps, but not certainly, belonging to the same colony. The long diameter of the present common stem of the larger specimen is 11 mm., the lesser diameter (antero-posterior) 9 mm.; these thicknesses are maintained approximately for most of the first internode, which is 25 mm. long; probable maximum lateral spread of branches 60 to 70 mm.; height above present base probably, when complete, about 200 mm.

Mr. Moseley has very liberally presented the specimens to the national collection; and I am much indebted to him for this opportunity of describing them. They were stated by the dealer from whom he obtained them to have been received from Japan, whence it was said that hundredweights came into the market, which, however, found but little sale. The locality is perhaps correct; but I have been unable, after diligent search, to find any record, either in scientific writings and travels, or in works of general information, of the occurrence of any native Japanese coral which was at all likely to belong to the *Coralliidæ*. To Messrs. Franks and Read, of the Ethnological Department in the British Museum, I am much indebted for information bearing on the subject. Mr. Franks has in his private collection a number of Japanese carved figures, called in Japan "netsuki," in most of which small dark men of a peculiar physiognomy, not Japanese, are represented as carrying coral, or (though this point is not so certain) as bringing it up from the sea. The coral thus depicted is either of actual specimens of *Corallium* or consists of carvings apparently representing it. Japanese writings call these men "black men." It is certain that they are not intended for Japanese; and as the men associated, whether in the ornaments

or writings, with Precious Coral appear to be always of this foreign type, it seems certain that it is generally known in that country as a foreign product. The pieces of coral which actually form part of the ornaments, and which the men clasp or carry, is certainly not the form under notice, but appears to be *Corallium nobile* in all cases; it was of rather a pale colour in all the specimens which I have seen. All these specimens are antecedent in date of manufacture to the period at which the Japanese ports were opened to European commerce. Prof. Moseley has drawings of quite a similar character. Precious coral is widely used in the East for ornaments, especially in China, where Mr. Franks informs me that an Empress's necklace has been made of alternate pieces of jade and coral. In this case it is probably all derived from the Mediterranean, as the value placed upon it in the instance just mentioned is more than the Chinese would have set upon a native production, or probably even on one from Japan. Prof. Moseley says that the Japanese use *Corallium* as an ornament and in "netsukis" abundantly, that he imagined it came from the Mediterranean, but that several residents have told him that it occurs native in Japan. None was found there by the 'Challenger.' A friend of Prof. Moseley told him that he had seen plenty of Red Coral which had been obtained at Japan, but subsequently was doubtful that it might not have been a *Distichopora*.

After considering all the evidence, I have still doubts as to whether the present specimens really are from Japan. It seems certain that much *Corallium nobile* has been imported into that country, probably by way of China. This is shown by Mr. Franks's ornaments to constitute at any rate the main origin of this substance for manufacturing-purposes in Japan. As the present species, from its hardness, compact structure, and deep colour, is hardly less fitted for those purposes than *C. nobile* itself, it would almost certainly have been thus employed if it were generally known in the country.

In regard to the relations of the form, it may be seen at once to agree very closely with *Pleurocorallium johnsoni* (Pl. IX. fig. 5) in all essential characters, as the two forms of spicules, which are almost exactly identical in the two species—the cylindrical radiate of var. *elatio*r having, however, but 6 radii as a rule; the axis, also, is striated and party-coloured in the stem, instead of white and smooth; and the cortex, besides being thinner, is scarlet instead of cream-coloured. However, it is undoubtedly a *Pleurocorallium*. Its relations to the original form of the species of which I have made it a variety are less certain. Unfortunately, as mentioned above, we are not acquainted with the characters of the spicules of *Pleurocorallium secundum*. From its resemblance to the present species in the party-coloured axis, pinnated branches, scarlet cortex with truncate Pleurocorallian verrucæ, it appears at any rate to be nearly related to it; but as the verrucæ are said to be placed mainly on the pinnae and not, as here, on the face of the branches, I think it may possibly be distinct. In that case I should propose the name *elatio*r for the present form, on account of its more erect and ramose habit; meanwhile it may stand as var. *elatio*r. The pinnate arrangement of the

lateral small branches on the sides of the large ones, the antero-posterior flattening, the rigidly anterior position of the verrucæ of the general surface, their abrupt projection and truncate extremity, separate it from all other species; while the minute characters, such as the double spicular complement, with its very remarkable form no. ii.—absent as it is from two of the recent *Coralliidæ* in which the spicules are known, and approximating the genus (as it appears to me to do) to the *Melithaidæ*, from its resemblance to the “Blattkeule” so widely distributed in that family—unmistakably show its true position to be by the side of *Pl. johnsoni*. The chief differences between the species are the red colour of the greater part of the hard axis and of the cortex, the absence of the terminal tubercles to the cylindrical spicule no. i., and the smaller size of the verrucæ, in the present form.

Key to the Genera, Species, and Varieties.

I have here endeavoured to present what appears to be the natural relations of the different forms, while giving characters which may readily distinguish them.

- I. Spicules of one kind, viz. octoradiate cylindrical. Verrucæ distributed over whole surface of corallum, prominent, monticular CORALLIUM s. str.
1. Corallum branching in more than a single plane.
- i. Axis cylindrical; spicules about .09 mm. long.
- | | | |
|---|---|--|
| a. Axis crimson, cortex red | { <i>C. nobile</i> ,
typical form. } | } <i>Known habitats.</i>
Mediterranean;
Cape Verd Isl. |
| β. Axis and cortex yellowish-white to white | { <i>C. nobile</i> ,
pale var. } | |
- ii. Spicules?; axis pale
- | | |
|---|---|
| { <i>C. pallidum</i> ,
?= <i>C. rubrum</i> . } | } Fossil; Tertiaries
of Italy and
Scinde; not
earlier than
Miocene. |
|---|---|
2. Corallum branching in but one plane, calicles sunk in pits in axis.
Axis oval in transverse section, white; spicules about .06 mm. long; cortex very pale orange, very thin *C. stylasteroides*. Mauritius.
- II. Spicules of two kinds, radiate cylindrical and opera-glass-shaped; calicles rising abruptly, truncate, those of stem and main branches confined to anterior surface. Corallum with lateral pinnae to main branches. Axis oval in transverse section..... PLEUROCORALLIUM, Gray, emend.
1. Axis partly red, partly white; cortex scarlet.
- i. Calicles chiefly on lateral pinnae ... *Pl. secundum*, ... “Sandwich Is.?”
- ii. Calicles chiefly on main branches; cylindrical spicules normally 6-radiate
- | | |
|--|----------|
| { <i>Pl. secundum</i> ,
var. <i>elatior</i> . } | } Japan? |
|--|----------|
2. Axis white, cortex cream-coloured; cylindrical spicules normally 8-radiate *Pl. johnsoni* Madeira.
- III. (*incertæ sedis*). Corallum with branches anastomosing, apices nodose
- | | |
|--|------------------------------------|
| { <i>Corallinum</i>
<i>beckii</i> | } Fossil; White
Chalk of Faxôe. |
|--|------------------------------------|

Relation of the Coralliidæ to other Families.

The opera-glass-shaped spicule of *Hemicorallium* resembles strongly some forms of the "Blattkeule" (Kölliker), or foliar clavate spicule, which is found in so many species of the family *Melithæidæ*, and but unfrequently elsewhere (see *Muricea*, *Eunicea*), that I am led to believe that we have in it a hint as to the sequence of forms connecting that family with the *Coralliidæ*; and it seems to me that *Pleurocorallium* on the one hand, and *Mopsella* on the other, mark the points at which the chain of continuity between the families has been broken. It is true, all the *Melithæidæ* do not possess this form, or at any rate not in its typical shape; but those which I believe to be the central forms of that family, viz. the genus *Mopsella* (Verrill, = *Melitella* and *Mopsella*, Gray), do show it well developed; and it may probably be traced, though under strange modifications, in the genus *Melitodes*. On the other hand, the peculiar cylindrical form of the *Coralliidæ* appears to me to represent a highly specialized form of the fusiform or cylindrical spicule which is an almost universal constituent of the cortex of the *Gorgoniidæ*, and which occurs in a usually unspecialized form in the *Melithæidæ* also.

With respect to the *Isididæ*, their strongly calcified calcareous joints forcibly recall the hard tissue of the *Coralliidæ*, with which they are homologous; and all the spicules found in their cortex appear (see Kölliker, *Icon. Histiol.* p. 140, pl. xix. figs. 1-3) to be referable to a sexradiate form very closely resembling, except in its larger size, that of the red *Pleurocorallium*; the separation of the hard pieces of the axis by *horny* joints, however, perhaps puts the family at a greater distance from the *Coralliidæ* than the *Melithæidæ*, in which these joints are already calcified. These horny joints, coupled with the absence of any spicule resembling the Melithæid "Blattkeule," removes the family from the neighbourhood of the *Melithæidæ*; and it probably represents a primitive offshoot from the same stem as that from which the genus *Corallium* s. str. has arisen.

Fossil Species.—In addition to the forms described as *C. pallidum* and *C. beckii*, mentioned above under *Corallium stylasteroides*, and to *C. nobile*, also noticed above as recently recorded in the fossil state from the Italian tertiaries, it may be observed that Prof. P. M. Duncan notices, *Geol. Journ.* xxxi. p. 675, some fragmentary specimens from the Oligocene of Oawaru, New Zealand, and refers them to *Corallium*, without assigning specific names: some of these are said to possess frequently-branching furrows and ridges on their surface, much developed and very irregular in distribution; they appear to somewhat resemble parts of *C. stylasteroides*; but no conclusions as to specific affinity can safely be based upon them.

As *Corallium nobile* has a white variety, and as Prof. Duncan states that he has found specimens of *C. pallidum* with a slight pink colour, and points out how slight are the differences between the species, I do not see how that species can be maintained as distinct from *C. nobile*, the colour, looser texture of corallum, and more minute striæ being the only distinctive characters given by Michelin. Seguenza (*l. c.*) speaks of fossil specimens of *C. nobile* without the





J. Smith del.

BOS FRONTALIS

Hambars ing.